# 1310/1490 Integrated Diplexer Transceiver

## Features

• Simplex SC Connector, Integrated Diplexer Transceiver

• SFP MSA, digital diagnostics SFF-8472 Compliant

• Voice/Data FTTx ONT/ONU Applications

• Compliant to FSAN G.984.5 Specifications

• 1244 Mbps Tx, 2488 Mbps Rx Asymmetric Data Rate

• Burst Mode Transmission

• TX Burst Mode Detection, TX_SD

• RX Squelch

• Operating case temperature: -40~85℃

• 28 dB link budget; Class B+; 20km reach

• Compliant to IEC-60825 Class 1 laser diode

• RoHS Compliant

• Internal Calibration

**- Digital Transmitter:** A DFB laser diode is employed for upstream transmission at OC-24 (1244Mbps).    The optical transmitter includes a back facet photodetector to monitor laser power for APC loop control.

**- Digital Receiver:** An APD with TIA is employed for downstream data reception at OC-48 (2488Mbps). A post amplifier is also included for CML output compatibility.
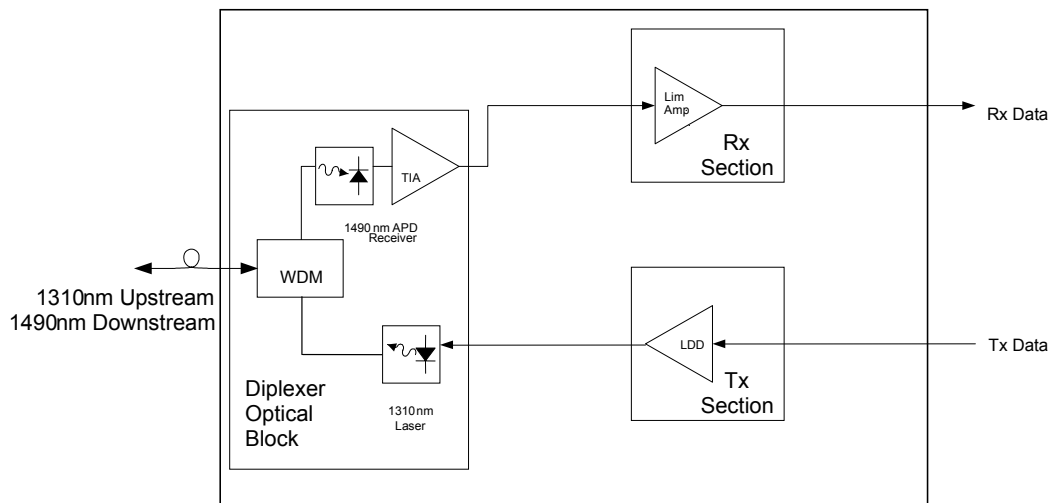


Diplexer Block Diagram

## Absolute Maximum Ratings

Usage of this transceiver shall adhere to the following absolute maximum ratings. Stresses beyond those in Table 1 may cause permanent damage to the unit.   These are stress ratings only, and functional operation of the unit at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied.   Exposure to absolute maximum rating conditions for extended periods may affect unit reliability.

**Table 1 - Absolute Maximum Ratings**

| Parameter | Minimum | Maximum | Unit/Conditions |
|---|---|---|---|
| Ambient Storage Temperature | -40 | 85 | ºC |
| Operating Temperature* | -40 | 85 | ºC |
| Operating Humidity Range | 5% | 95% | non-condensing |
| ESD Sensitivity (Human Body Model) | - | 1000 | V |
| Lead Soldering Temperature | - | 260ºC | Maximum 10 sec |
| Vcc_Rx | -0.4 | +4.2 | V |
| Vcc_Tx | -0.4 | Vcc_Rx + 1 | V |

## Module Characteristics

**Table 2 - Module Characteristics**

| Parameter | Minimum | Typical | Maximum | Unit/Conditions |
|---|---|---|---|---|
| 1310nm Tx to 1490nm Rx Crosstalk | - | - | -47 | dB |
| 1555nm Rx to 1490nm Isolation | 30 | - | - | dB |
| G.984.5 Wavelength Blocking Filter (WBF) | 7 | - | - | dB, 1441 nm to 1450 nm |
| | 7 | - | - | dB, 1530 nm to 1539 nm |
| | 22 | - | - | dB, 1400 nm to 1441 nm |
| | 22 | - | - | dB, 1539 nm to 1625 nm |
| Total TX and RX Supply Current | - | - | 350 | mA |

# Functional Characteristics

The following tables list the performance specifications for the various functional blocks of the integrated optical transceiver module.

| Table 3 – Digital Transmitter Specifications | | | | | |
|---|---|---|---|---|---|
| Parameter | Minimum | Typical | Maximum | Unit | Notes |
| Operating Voltage | 3.14 | 3.30 | 3.46 | V | $V_{CC}$ referenced to GND_Tx |
| Data Rate | - | 1244.16 | - | Mbps | |
| Average Optical Output Power, $P_O$ | 0.5 | - | 5 | dBm | |
| Output Power at Transmit Off | - | - | -45 | dBm | |
| Extinction Ratio | 10 | - | - | dB | PRBS $2^{23}$-1, NRZ, 50% duty cycle |
| Transmitter Output Eye | G.984.2 Figure 3 | | | | |
| Optical Rise and Fall Time | - | 250 | - | ps | 20% to 80% |
| Side Mode Suppression Ration (SMSR) | 30 | | | dB | |
| Center Wavelength | 1290 | | 1330 | nm | |
| -20dB Spectral Width | | | 1 | nm | |
| Differential Input Voltage | 300 | - | 1800 | mVp-p | TXD+/-. Internally DC-coupled |
| Input Impedance | - | 100 | - | Ω | CML input/R3=100ohm |
| Common-Mode Input Voltage | GND_Tx + 1.4 | - | Vcc - ($V_{in}$/2) - 0.1 | V | Internally DC coupled |
| Tx Burst Enable Time | - | - | 12.86 | ns | 16 bits data @ 1244Mbps |
| Tx Burst Disable Time | - | - | 12.86 | ns | 16 bits data @ 1244Mbps |
| Jitter Generation | - | - | 0.2 | UI | 4 kHz to 10 MHz |

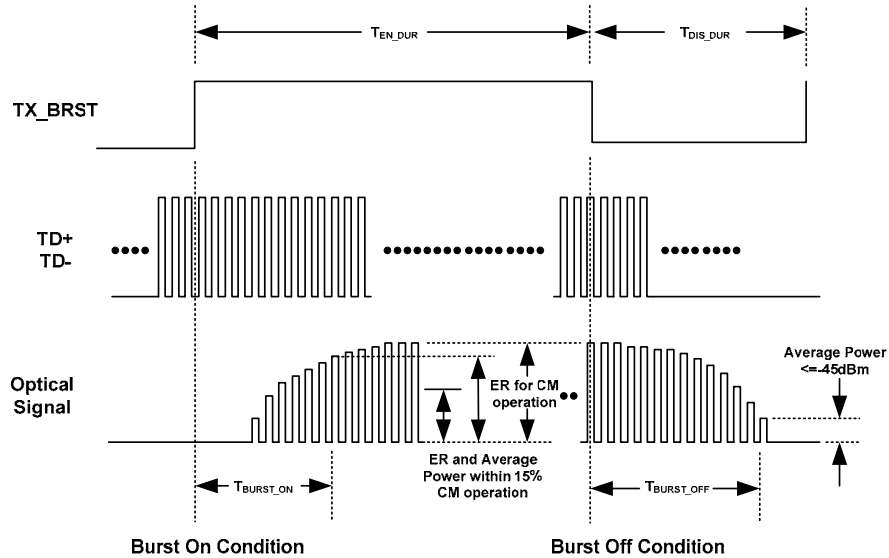Refer to Figure 1 which schematically describes the timing parameter definition in burst mode sequence.



**Figure 1 - Timing Parameter Definition in Burst Mode Sequence**

| Table 4 – Digital Receiver Specifications | | | | | |
|---|---|---|---|---|---|
| Parameter | Minimum | Typical | Maximum | Unit | Notes |
| Operating Voltage | 3.14 | 3.30 | 3.46 | V | $V_{CC}$ referenced to GND_RX |
| Data Rate | - | 2488.32 | - | Mbps | |
| Operational Wavelength Range | 1480 | - | 1500 | nm | |
| Received Optical Power (BOL) | -28 | - | -8 | dBm | BER≤$10^{-10}$, PRBS $2^{23}$-1, 50% duty cycle |
| Received Optical Power (EOL) | -27 | - | -8 | dBm | |
| Data Output Rise and Fall Time | - | 160 | - | ps | 20% to 80% |
| Signal Detect Assert Level | - | - | -29 | dBm | Transition during increasing light |
| Signal Detect De-assert Level | -45 | - | - | dBm | Transition during decreasing light |
| Hysteresis | 0.5 | - | - | dB | |
| Differential Output Voltage | 300 | - | 1200 | mV | CML output, ac coupled |
| Signal Detect Output HIGH Voltage | 2.4 | - | - | V | LVTTL with internal pull up resistor. Asserts HIGH when input data amplitude is above threshold. |
| Signal Detect Output LOW Voltage | - | - | 0.6 | V | LVTTL with internal pull up resistor. De-asserts LOW when input data amplitude is below threshold. |

**Table 5 - Microcontroller Specifications**

| Parameter | Minimum | Typical | Maximum | Unit | Notes |
|---|---|---|---|---|---|
| Operating Voltage | 3.14 | 3.30 | 3.46 | V | |
| SDA[a] | - | - | - | - | LVTTL, open collector serial data line from the I$^2$C bus to the on board Microcontroller. |
| SCL[b] | - | - | - | - | LVTTL, open collector serial clock line from the I$^2$C bus to the on board Microcontroller. 400kbps max. data rate. |

[a] I$^2$C SDA and SCL must be open collector or open drain connections.

[b] Clock stretching, as per paragraph 13.2 of the I$^2$C Bus Standard, must be implemented to operate correctly.
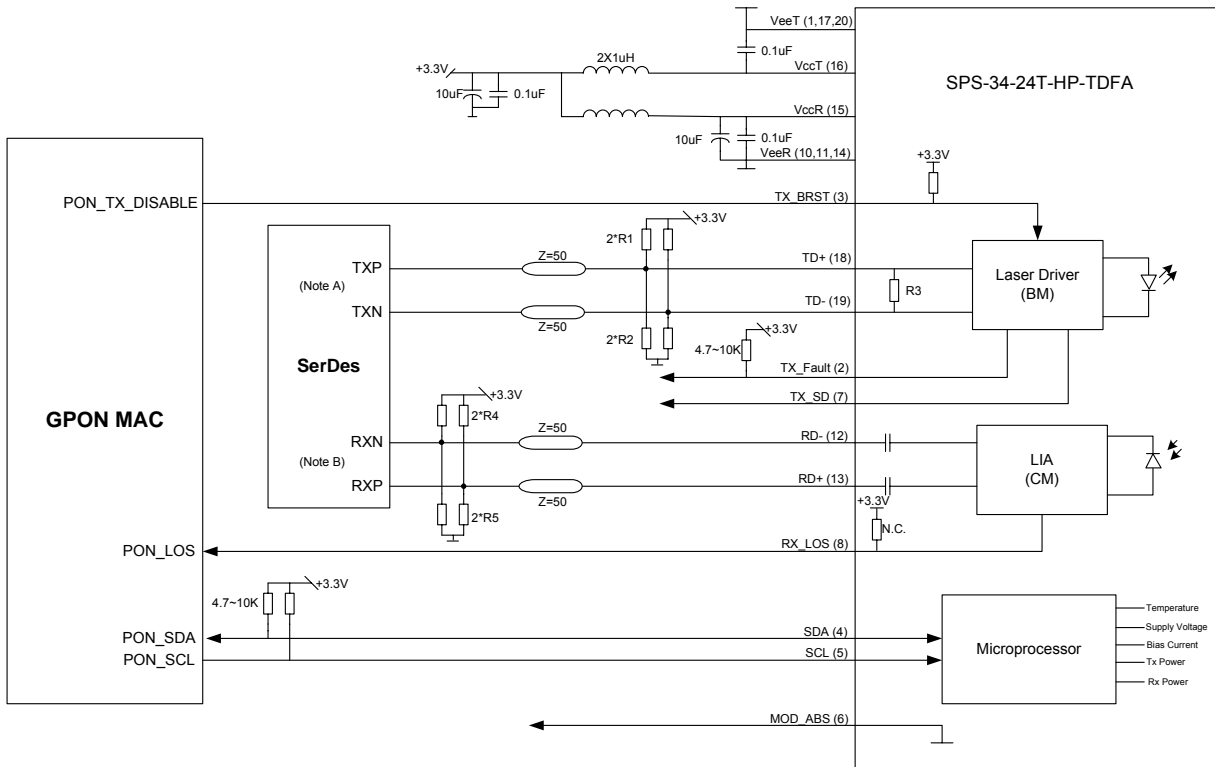
# Recommended Interface Circuit



**Figure 2 – Recommended interface circuit**

Note A: Output stage in SerDes IC is LVPECL output, R1=130ohm, R2=82ohm, R3=N.C.
   Output stage in SerDes IC is CML output, R1=N.C., R3=100ohm.
Note B: CML output, AC coupled internally.
   Input stage in SerDes IC is LVPECL input, R4=82ohm, R5=130ohm
   Input stage in SerDes IC is CML input, R4=R5=N.C.

# Pin Definitions

Refer to 错误！未找到引用源。6 for a description of the function of each I/O pin.

| Table 6 - Module Pin Definitions | | | |
|---|---|---|---|
| **Pin Number** | **Label** | **Definition** | **Note** |
| 1 | VeeT | Module Transmitter Ground | |
| 2 | TX_FAULT | Module Transmitter Fault | |
| 3 | TX_BRST | Transmitter Burst Control, Active High | |
| 4 | SDA | 2-Wire Serial Interface Data Line (MOD-DEF2) | 1 |
| 5 | SCL | 2-Wire Serial Interface Clock (MOD-DEF1) | 1 |
| 6 | MOD_ABS | Module Absent, connected to VeeT or VeeR in the module | |
| 7 | TX_SD | TX Signal Detect | 2 |
| 8 | RX_SD | Receiver Signal Detect | |
| 9 | NC | Not connected | |
| 10 | VeeR | Module Receiver Ground | |
| 11 | VeeR | Module Receiver Ground | |
| 12 | RXD- | Receiver Inverted Data Output | |
| 13 | RXD+ | Receiver Non-Inverted Data Output | |
| 14 | VeeR | Module Receiver Ground | |
| 15 | VCCR | Module Receiver 3.3V Supply | |
| 16 | VCCT | Module Transmitter 3.3V Supply | |
| 17 | VeeT | Module Transmitter Ground | |
| 18 | TXD+ | Transmitter Non-Inverted Data Input, CML with 100ohm differential impedance | |
| 19 | TXD- | Transmitter Inverted Data Input, CML with 100ohm differential impedance | |
| 20 | VeeT | Module Transmitter Ground | |

Note

1. This pin is an open collector/drain output pin and shall be pulled up with 4.7K-10K ohms to a Host_Vcc on the host board.
2. TX Signal Detect, TX Active State: High.

Optical Output
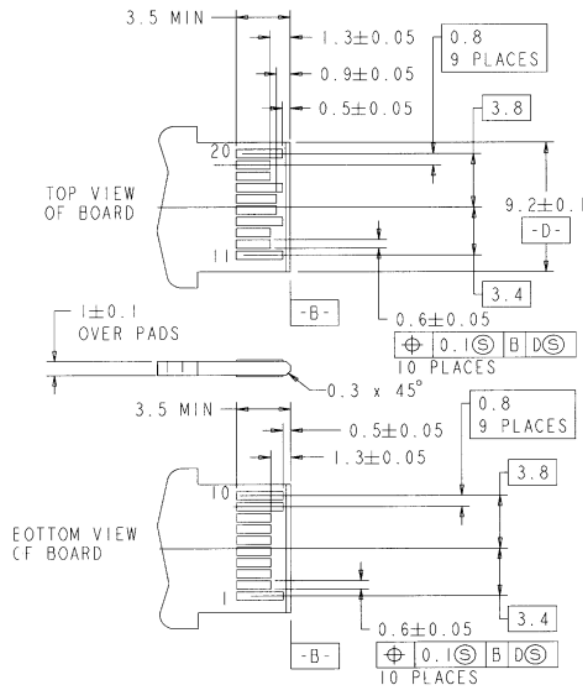Signal

Tx_ SD Output
Signal

100ns          50ns
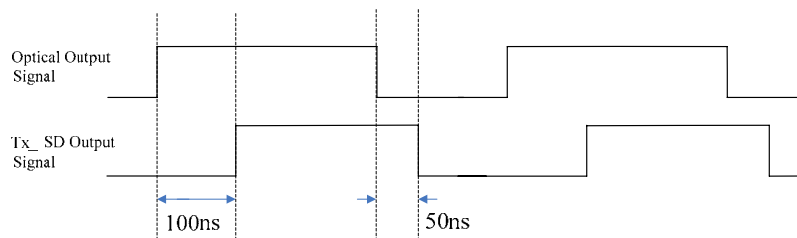
## Pin Assignment



**Figure 3, SFP Pin View (Golden Finger)**
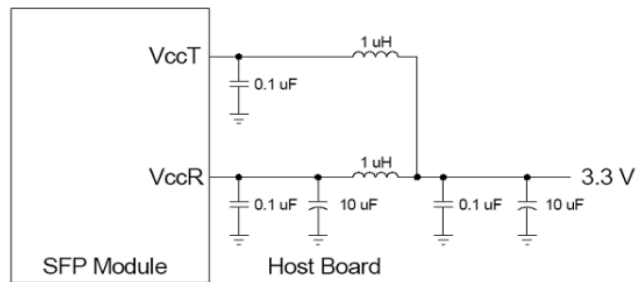
## Recommended Host Board Power Supply Circuit



**Figure 4, Recommended Host Board Power Supply Filtering Network**

## Digital Diagnostics Monitor Accuracy

**Table 7 - Diagnostics**

| Parameter | Range | Accuracy | Unit | Calibration |
|-----------|-------|----------|------|-------------|
| Temperature | -40 to 100 | ±3 | ºC | Internal |
| Voltage | 0 to Vcc | ±3% | V | Internal |
| Bias Current | 0 to 100 | ±10% | mA | Internal |
| Tx Power | -1 to 5 | ±2 | dB | Internal |
| Rx Power | -28 to -8 | ±3 | dB | Internal |

Note

1. Temperature and voltage are measured internal to the transceiver.

2. Bias monitor is specified by nominal bias value at continuous mode.
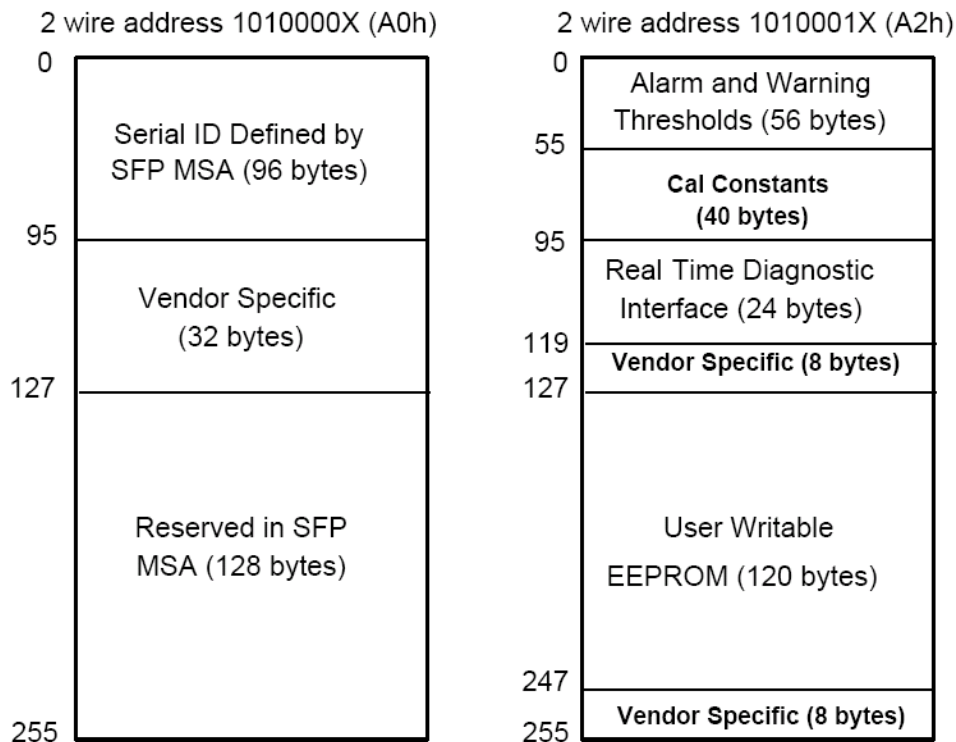
## EEPROM information



**Figure 5, 2-wire Serial Digital Diagnostic Memory Map**

**Table 8 - EEPROM Serial ID Memory Contents (A0h)**

| Addr. | Field Size (Bytes) | Name of Field | Hex | Description |
|---|---|---|---|---|
| 0 | 1 | Identifier | 03 | SFP transceiver |
| 1 | 1 | Ext. Identifier | 04 | MOD4 |
| 2 | 1 | Connector | 01 | SC |
| 3-10 | 8 | Transceiver | 00 00 00 00 00 00 00 00 | |
| 11 | 1 | Encoding | 03 | NRZ |
| 12 | 1 | BR, Nominal | 0C | 1.244Gbps |
| 13 | 1 | Reserved | 00 | |
| 14 | 1 | Length (9um)-km | 14 | 20(km) |
| 15 | 1 | Length (9um) | C8 | 200(100m) |
| 16 | 1 | Length (50um) | 00 | Not Support MMF |
| 17 | 1 | Length (62.5um) | 00 | Not Support MMF |
| 18 | 1 | Length (Copper) | 00 | Not Support Copper |
| 19 | 1 | Reserved | 00 | |
| 20-35 | 16 | Vendor name | 53 4F 55 52 43 45 50 48 4F 54 4F 4E 49 43 53 20 | "SOURCEPHOTONICS "(ASCⅡ) |
| 36 | 1 | Reserved | 00 | |
| 37-39 | 3 | Vendor OUI | 00 00 00 | |
| 40-55 | 16 | Vendor PN | 53 50 53 33 34 32 34 54 48 50 54 44 46 41 20 20 | "SPS3424THPTDFA" (ASCII) |
| 56-59 | 4 | Vendor Rev | xx xx 20 20 | ASCII("31 30 20 20" means 1.0 Revision) |
| 60-61 | 2 | Wavelength | 05 1E | 1310nm Laser Wavelength |
| 62 | 1 | Reserved | 00 | |
| 63 | 1 | CC_BASE | xx | Check sum of byte 0-62 |
| 64-65 | 2 | Options | 00 0C | Rx_SD, Tx_Fault |
| 66 | 1 | BR, max | 00 | |
| 67 | 1 | BR, min | 00 | |
| 68-83 | 16 | Vendor SN | xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx | ASCII |
| 84-91 | 8 | Date code | xx xx xx xx xx xx 20 20 | Year(2 bytes),Month(2 bytes), Day(2 bytes) |
| 92 | 1 | Diagnostic Monitoring Type | 68 | Compliant with SFF-8472 V9.5 Internally Calibrated Received power measurement type -Average Power |
| 93 | 1 | Enhanced Options | F0 | Diagnostics (Optional Alarm/warning flags) Soft TX_FAULT monitoring implemented |

| | | | | Soft RX_LOS monitoring implemented |
|---|---|---|---|---|
| 94 | 1 | SFF-8472 Compliance | 02 | Diagnostics Compliance(SFF-8472 V9.5) |
| 95 | 1 | CC_EXT | xx | Check sum of byte 64-94 |
| 96-255 | 64 | Vendor Specific | | |

**Table 9 - EEPROM Serial ID Memory Contents (A2h)**

| Addr. | | Field Size (Bytes) | Name of Field | Hex | Description |
|---|---|---|---|---|---|
| 0 | 00 | 2 | Temp High Alarm | 64 00 | 100℃ |
| 2 | 02 | 2 | Temp Low Alarm | CE 00 | -50℃ |
| 4 | 04 | 2 | Temp High Warning | 5A 00 | 90℃ |
| 6 | 06 | 2 | Temp Low Warning | D8 00 | -40℃ |
| 8 | 08 | 2 | Voltage High Alarm | 8C A0 | 3.6V |
| 10 | 0A | 2 | Voltage Low Alarm | 75 30 | 3.0V |
| 12 | 0C | 2 | Voltage High Warning | 88 B8 | 3.5V |
| 14 | 0E | 2 | Voltage Low Warning | 79 18 | 3.1V |
| 16 | 10 | 2 | Bias High Alarm | AF C8 | 90mA |
| 18 | 12 | 2 | Bias Low Alarm | 00 00 | 0mA |
| 20 | 14 | 2 | Bias High Warning | 88 B8 | 70mA |
| 22 | 16 | 2 | Bias Low Warning | 00 00 | 0mA |
| 24 | 18 | 2 | TX Power High Alarm | 7B 86 | 5dBm |
| 26 | 1A | 2 | TX Power Low Alarm | 22 D0 | -0.5dBm |
| 28 | 1C | 2 | TX Power High Warning | 6E 17 | 4.5dBm |
| 30 | 1E | 2 | TX Power Low Warning | 27 10 | 0dBm |
| 32 | 20 | 2 | RX Power High Alarm | 07 CB | -7dBm |
| 34 | 22 | 2 | RX Power Low Alarm | 00 0F | -28dBm |
| 36 | 24 | 2 | RX Power High Warning | 06 30 | -8dBm |
| 38 | 26 | 2 | RX Power Low Warning | 00 14 | -27dBm |
| 40 | 28 | 16 | Reserved | 00….000 | Reserved |
| 56 | 38 | 4 | RX_PWR(4) Calibration | 00 00 00 00 | 4th order RSSI calibration coefficient |
| 60 | 3C | 4 | RX_PWR(3) Calibration | 00 00 00 00 | 3rd order RSSI calibration coefficient |
| 64 | 40 | 4 | RX_PWR(2) Calibration | 00 00 00 00 | 2nd order RSSI calibration coefficient |
| 68 | 44 | 4 | RX_PWR(1) Calibration | 3F 80 00 00 | 1st order RSSI calibration coefficient |
| 72 | 48 | 4 | RX_PWR(0) Calibration | 00 00 00 00 | 0th order RSSI calibration coefficient |
| 76 | 4C | 2 | TX_I(Slope) Calibration | 01 00 | Slope for Bias calibration |
| 78 | 4E | 2 | TX_I(Offset) Calibration | 00 00 | Offset for Bias calibration |
| 80 | 50 | 2 | TX_PWR(Slope) Calibration | 01 00 | Slope for TX Power calibration |

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| 82 | 52 | 2 | TX_PWR(Offset) Calibration | 00 00 | Offset for TX Power calibration |
|---|---|---|---|---|---|
| 84 | 54 | 2 | T(Slope) Calibration | 01 00 | Slope for Temperature calibration |
| 86 | 56 | 2 | T(Offset) Calibration | 00 00 | Offset for Temperature calibration, in units of 256ths C |
| 88 | 58 | 2 | V(Slope) Calibration | 01 00 | Slope for VCC calibration |
| 90 | 5A | 2 | V(Offset) Calibration | 00 00 | Offset for VCC calibration |
| 92 | 5C | 3 | Reserved | 00 00 00 | Reserved |
| 95 | 5F | 1 | Checksum | xx | Checksum |
| 96 | 60 | 2 | Transceiver Temperature | xx xx | Temperature in C/256 |
| 98 | 62 | 2 | Supply Voltage | xx xx | Vcc |
| 100 | 64 | 2 | TX Bias Current | xx xx | BIASMON |
| 102 | 66 | 2 | TX Optical Output Power | xx xx | Back facet monitor |
| 104 | 68 | 2 | RX Optical Input Power | xx xx | RSSI |
| 106 | 6A | 2 | Reserved | 00 00 | Reserved |
| 108 | 6C | 2 | Reserved | 00 00 | Reserved |
| 110 | 6E.7 | 1bit | TX_DIS State | x | Soft TX disable state |
| | 6E.6 | 1bit | Soft TX Disable | x | Write bit that allows software disable laser output. |
| | 6E.5 | 1bit | Reserved. | 0 | Reserved |
| | 6E.4 | 1bit | Rate Select State | 0 | NOT SUPPORTED. |
| | 6E.3 | 1bit | Rate Select | 0 | NOT SUPPORTED. |
| | 6E.2 | 1bit | TX_FAULT | x | Digital state of the TX Fault Output |
| | 6E.1 | 1bit | Rx LOS | x | Digital state of the Rx LOS Output |
| | 6E.0 | 1bit | Data Ready Bar | x | Indicates transceiver has achieved power up and data is ready. |
| 111 | 6F.7 | 1bit | Reserved | 0 | Reserved |
| | 6F.6 | 1bit | Reserved | 0 | Reserved |
| | 6F.5 | 1bit | Reserved | 0 | Reserved |
| | 6F.4 | 1bit | Reserved | 0 | Reserved |
| | 6F.3 | 1bit | Reserved | 0 | Reserved |
| | 6F.2 | 1bit | Reserved | x | Reserved |
| | 6F.1 | 1bit | Reserved | 0 | Reserved |
| | 6F.0 | 1bit | Reserved | x | Reserved |
| 112 | 70.7 | 1bit | Temperature too high alarm | x | Temperature too high alarm |
| | 70.6 | 1bit | Temperature too low alarm | x | Temperature too low alarm |
| | 70.5 | 1bit | VCC too high alarm | x | VCC too high alarm |
| | 70.4 | 1bit | VCC too low alarm | x | VCC too low alarm |
| | 70.3 | 1bit | BIASMON too high alarm | x | BIASMON too high alarm |

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| | | | | | |
|---|---|---|---|---|---|
| | 70.2 | 1bit | BIASMON too low alarm | x | BIASMON too low alarm |
| | 70.1 | 1bit | TX Power too high alarm | x | TX Power too high alarm |
| | 70.0 | 1bit | TX Power too low alarm | x | TX Power too low alarm |
| 113 | 71.7 | 1bit | RX Power too high alarm | x | RX Power too high alarm |
| | 71.6 | 1bit | RX Power too low alarm | x | RX Power too low alarm |
| | 71.5 | 1bit | Reserved interrupt status bit | x | Reserved interrupt status bit |
| | 71.4 | 1bit | Reserved interrupt status bit | x | Reserved interrupt status bit |
| | 71.3 | 1bit | Reserved interrupt status bit | x | Reserved interrupt status bit |
| | 71.2 | 1bit | Reserved interrupt status bit | x | Reserved interrupt status bit |
| | 71.1 | 1bit | Reserved interrupt status bit | x | Reserved interrupt status bit |
| | 71.0 | 1bit | Reserved interrupt status bit | x | Reserved interrupt status bit |
| 114 | 72 | 1 | Reserved | 00 | Reserved |
| 115 | 73 | 1 | Reserved | 00 | Reserved |
| 116 | 74.7 | 1bit | Temperature too high warning | x | Temperature too high warning |
| | 74.6 | 1bit | Temperature too low warning | x | Temperature too low warning |
| | 74.5 | 1bit | VCC too high warning | x | VCC too high warning |
| | 74.4 | 1bit | VCC too low warning | x | VCC too low warning |
| | 74.3 | 1bit | BIASMON too high warning | x | BIASMON too high warning |
| | 74.2 | 1bit | BIASMON too low warning | x | BIASMON too low warning |
| | 74.1 | 1bit | TX Power too high warning | x | TX Power too high warning |
| | 74.0 | 1bit | TX Power too low warning | x | TX Power too low warning |
| 117 | 75.7 | 1bit | RX Power too high warning | x | RX Power too high warning |
| | 75.6 | 1bit | RX Power too low warning | x | RX Power too low warning |
| | 75.5 | 1bit | Reserved interrupt status bit | 0 | Reserved interrupt status bit |
| | 75.4 | 1bit | Reserved interrupt status bit | 0 | Reserved interrupt status bit |
| | 75.3 | 1bit | Reserved interrupt status bit | 0 | Reserved interrupt status bit |
| | 75.2 | 1bit | Reserved interrupt status bit | 0 | Reserved interrupt status bit |
| | 75.1 | 1bit | Reserved interrupt status bit | 0 | Reserved interrupt status bit |
| | 75.0 | 1bit | Reserved interrupt status bit | 0 | Reserved interrupt status bit |
| 118 | 76 | 1 | Reserved | 00 | Reserved |
| 119 | 77 | 1 | Reserved | 00 | Reserved |
| 120 | 78 | 8 | Vendor Specific | 00 00 00 00 00 00 00 00 | Vendor Specific |

## Mechanical Diagram
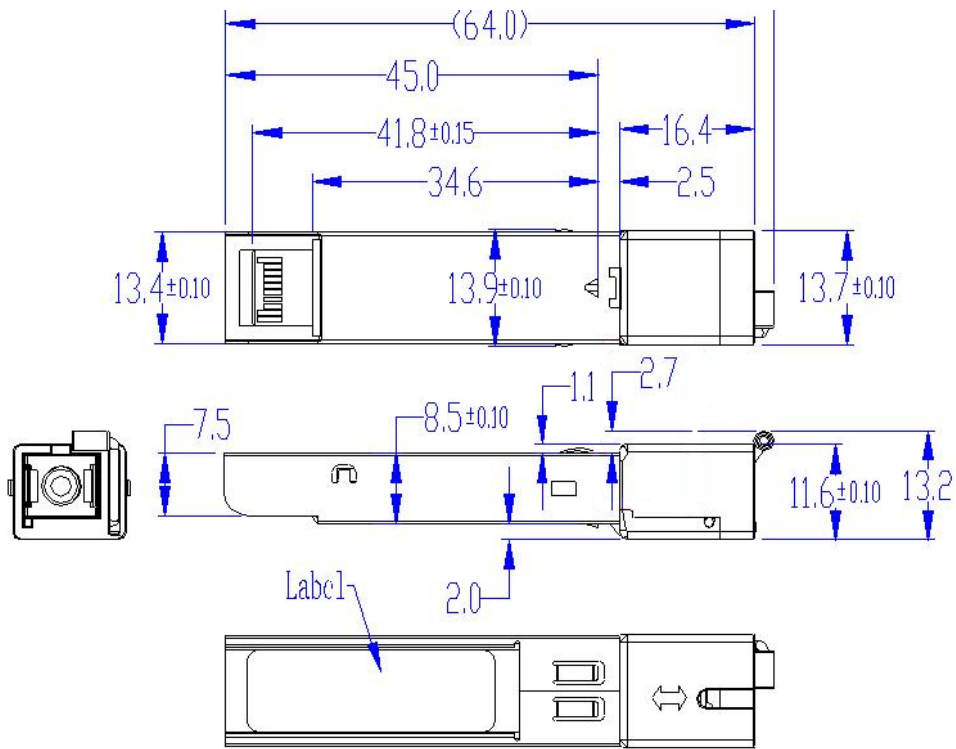
# Ordering Information

| Table 10 – Valid Part Numbers | |
|---|---|
| **Part Number** | **Description** |
| SPS-34-24T-HP-TDFA | GPON ONT diplexer optical transceiver, SFP, Industrial temperature range operation |

| Table 11 - Device Handling/ESD Protection | |
|---|---|
| The devices are static sensitive and may easily be damaged if care is not taken during handling. The following handling practices are recommended. | |
| 1 | Devices should be handled on benches with conductive and grounding surfaces. |
| 2 | All personnel, test equipment and tools shall be grounded. |
| 3 | Do not handle the devices by their leads. |
| 4 | Store devices in protective foam or carriers. |
| 5 | Avoid the use of non-conductive plastics, rubber, or silk in the area where the devices are handled |
| 6 | All modules shall be packaged in materials that are anti-static to protect against adverse electrical environments. |
| 7 | Avoid applications of any voltage higher than maximum rated voltages to this part.   For proper operation, any VIN or VOUT should be constrained to the range $GND \leq (VIN$ or $VOUT) \leq VCC$.   Unused inputs must always be tied to an appropriate logic voltage   (e.g. either GND or VCC).   Unused outputs must be left open. |

## Warnings

Handling Precautions: This device is susceptible to damage as a result of electrostatic discharge (ESD). A static free environment is highly recommended. Follow guidelines according to proper ESD procedures.

Laser Safety: Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.

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